

APPLICATION
FOR
UNITED STATES LETTERS PATENT

PATENT APPLICATION

SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

Be it known that Daniel E. E. Hayes, Jr. of 6500 Wagon Loop, Placerville, CA 95667 and Alfred S. Despres III of 4607 Hillwood Drive, Shingle Springs, CA 95682 have invented certain improvements in BIMETAL ACETABULAR COMPONENT CONSTRUCT FOR HIP JOINT PROSTHESIS of which the following description is a specification.

JES/HAYES4.CVR

BIMETAL ACETABULAR COMPONENT CONSTRUCT
FOR HIP JOINT PROSTHESIS

Reference To Pending Prior Applications

5 This application claims benefit of (1) pending prior U.S. Patent Application Serial No. _____, filed 07/09/01 by Alfred S. Despres III et al. for IMPLANT WITH COMPOSITE COATING (Attorney's Docket HAYES-707 CON), which is in turn a continuation of prior U.S. Patent Application Serial No. 09/079,502, filed 05/14/98 by Alfred S. Despres III et al. for IMPLANT WITH COMPOSITE COATING (Attorney's Docket No. 13928-707/HAYES 079502/HAYES-707), and (2) pending prior U.S. Provisional Patent Application Serial No. 60/219,962, filed 07/20/00 by Daniel E. E. Hayes, Jr. et al. for BIMETAL ACETABULAR COMPONENT CONSTRUCT (Attorney's Docket No. HAYES-4 PROV).

10 The two above-identified patent applications are hereby incorporated herein by reference.

Field Of The Invention

This invention relates to surgical apparatus and procedures in general, and more particularly to orthopedic prostheses for restoring the hip joint.

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Background Of The Invention

Joint replacement surgery seeks to replace portions of a joint with prosthetic components so as to provide long-lasting function and pain-free mobility.

For example, in the case of a prosthetic total hip joint, the head of the femur is replaced with a prosthetic femoral stem component, and the socket of the acetabulum is replaced by a prosthetic acetabular cup component, whereby to provide a prosthetic total hip joint.

In the case of a prosthetic total knee joint, the top of the tibia is replaced by a prosthetic tibial component, and the bottom of the femur is replaced by a prosthetic femoral component, whereby to provide a prosthetic total knee joint.

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The present invention is directed to orthopedic prostheses for restoring the hip joint and, in particular, to improved prosthetic acetabular components.

5 There is a long and varied history in the use of different materials for joint replacement prostheses. Some early attempts, such as stainless steel hip prostheses, were found to be reasonably successful and are still in use today. Other attempts, such as acrylic femoral head replacements or Teflon "TMJ" replacements, were found to be unacceptable and have been abandoned.

10 Currently, combinations of materials are generally used to form joint replacement prostheses.

15 More particularly, in the case of a prosthetic total hip joint, the prosthetic femoral stem component typically comprises a metal, and the prosthetic acetabular cup component typically comprises a metal seat with a plastic liner.

20 In the case of a prosthetic total knee joint, the prosthetic tibial component typically comprises a

metal base topped with a plastic bearing surface, and the prosthetic femoral component typically comprises a metal.

The present state of the art is currently dominated by the use of three different materials: titanium and its alloys, cobalt-based alloys and polyethylene plastics. The two metallic materials are generally used for structural constructs (e.g., constructs that must carry the loads transmitted through the joint), and polyethylene is generally used as a bearing material in the joints (e.g., to slide or rotate against an opposing metallic component).

Ceramic bearing couples have also been used in the art to some extent, but their use is relatively limited due to price and strength considerations.

The vast majority of structural implant constructs are currently made from either titanium alloys (e.g., Ti6Al4V) or cobalt-based alloys (e.g. CoCr alloys, including CoCrMo alloys). These materials have different advantages and disadvantages.

More particularly, titanium alloys generally exhibit relatively high general fatigue strength, relatively low stiffness compared to alternative materials, and excellent biocompatibility properties.

5 Titanium alloys, however, also tend to suffer from notch sensitivity in fatigue, which significantly reduces the fatigue strength of the construct when the surface is notched, roughened or porous-coated. Titanium alloys are also prone to scratching and make relatively poor sliding couples with polyethylene.

10 CoCr alloys generally have relatively high fatigue strengths, are relatively notch insensitive, and are relatively tough and resistant to scratching, thus making them excellent candidates for forming sliding couples with polyethylene. However, CoCr 15 alloys are also relatively stiff, which can cause load pattern problems when coupled with flexible human bones, and they are not as biocompatible as many other alloys due to their chrome, and in some cases nickel, content.

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In the 1980's, titanium alloys were used in many applications to take advantage of their biocompatibility. However, the applications that included sliding surfaces, such as femoral heads for the hip and knee femoral components, tended to have significant problems with wear debris and scratching, and many exhibited clinical failure.

From this experience, implants were developed that combined the two aforementioned materials (i.e., titanium and CoCr alloys) in advantageous ways.

One early product was a knee femoral component that had a sliding surface of CoCr and a bone ingrowth surface of titanium. This design took advantage of CoCr's excellent wear characteristics in sliding articulations with the tibial component's polyethylene bearing, while still providing excellent bone ingrowth at the bone/prosthesis junction.

The aforementioned two materials (i.e., titanium and CoCr alloys) have also been used on hip femoral stem components. More particularly, hip femoral stem components have been developed which comprise an inner

core of CoCr covered with a coating of titanium for bone ingrowth. This layered construction is desirable because stems made entirely of titanium, with titanium ingrowth surfaces, are too weak, while stems that are made entirely of CoCr, with CoCr ingrowth surfaces, do not have adequate biocompatibility. The combination of these two materials in a single construct provides a stem that is strong enough and also has a good bone ingrowth surface.

Another attempt to improve the biocompatibility of the bone ingrowth surface has been to coat the surface with hydroxyapatite (HA). However, HA, while it yields excellent short term results, has problems with long term stability due to its pH sensitivity. More particularly, the pH of the body may fluctuate due to a variety of conditions such as nutrition and disease, and this can undermine the effectiveness of HA bone ingrowth surface.

Another attempt to increase the hardness of the articulating surface has been to coat the articulating surface with a ceramic such as titanium nitride. The

main limitation to this approach is that loading and abrading tend to undermine the mechanical integrity of the union between the ceramic coating and the substrate, and this can lead to prosthesis failure.

5 As wear issues relating to the main articulating surfaces have been addressed and incidences of gross and catastrophic wear eliminated, it has been discovered that the locking interface between the polyethylene bearing construct and the metal base construct can also be a significant source of wear debris. More particularly, it has been discovered that small sliding motions in the junction between the polyethylene bearing construct and the metal base construct produce particles of polyethylene that can migrate out of the joint and into the body. Small abrasive particles can also migrate into the interface between the polyethylene bearing construct and the metal base construct, particularly where the metal base construct is formed out of titanium. This issue of "backside

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wear" has been a significant issue for research and debate over the last five years or so.

Attempts to address this issue have, to date, been limited to polishing the titanium mating surface of the metal base construct, as disclosed in U.S. Patent No. 5,310,408 and as practiced in the "Reflection Cup" product marketed by Smith + Nephew of Memphis, Tennessee. However, polishing a titanium surface has not worked well in previous attempts in sliding couples (i.e., in the femoral head component of a prosthetic total hip and in the prosthetic femoral component of a prosthetic total knee), and it has had only limited success in reducing wear debris at the locking interface between the polyethylene bearing construct and the metal base construct. This is primarily due to the inherent material limitations of the titanium metal base construct in the polished locking mechanism configuration.

No existing metallic construct that assembles with a polyethylene bearing is made of two metals (i.e., is bimetallic).

No existing bimetallic constructs lock with polyethylene.

Summary Of The Invention

5 This invention provides for a novel orthopedic prosthesis, specifically a prosthetic acetabular component for a prosthetic total hip joint, that comprises two constructs, one being a metal base construct that engages the bone and the other being a polyethylene bearing construct that attaches to the metal base construct and articulates with a prosthetic hip component on the opposing side of the joint. The metal base construct is composed of two different metals, one of which engages the bone surface and the other of which engages the polyethylene bearing construct. Each of these metals is selected so that its characteristics are well suited to its particular function. More particularly, the first metal (i.e., the one that engages the bone surface) is selected so as to provide a superior bone-engaging face, while the second metal (i.e., the one that engages the

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polyethylene bearing construct) is selected so as to provide a superior polyethylene-engaging face. By combining the different material characteristics of two different metals in the metal base construct, it is possible to simultaneously form a superior bone-engaging face and a superior polyethylene-engaging face. Among other things, by selecting two appropriate metals for the metal base construct, superior bone ingrowth can be achieved while still avoiding the aforementioned problems with "backside wear".

Brief Description Of The Drawings

These and other objects and features of the present invention will be more fully disclosed or rendered obvious by the following detailed description of the preferred embodiments of the invention, which is to be considered together with the accompanying drawings wherein like numbers refer to like parts and further wherein:

Fig. 1 is a schematic side view showing a prosthetic total hip joint positioned within a patient's body;

5 Fig. 2 is an exploded schematic side view showing the prosthetic acetabular component of the prosthetic total hip joint shown in Fig. 1; and

Fig. 3 is a schematic side view of the prosthetic acetabular component of the prosthetic total hip joint shown in Fig. 1.

Detailed Description Of The Preferred Embodiments

10 Looking first at Fig. 1, there is shown a prosthetic total hip joint 5 which generally comprises a prosthetic acetabular component 10 seated in a recess contained in a prepared hip 15, and a prosthetic femoral stem component 20 which is secured to the top end of a resected femur 25.

15 Prosthetic acetabular component 10 is shown in greater detail in Figs. 2 and 3. Prosthetic acetabular component 10 generally comprises a metal

base construct 30 and a polyethylene bearing construct 35.

More particularly, metal seat base construct 30 comprises a metal seat 40 with a rail 60 defining a groove 65 therein.

5 Polyethylene liner construct 35 comprises a domed top surface 75 having an annular flange 85. Flange 85 is sized to snap fit in the groove 65 of metal base construct 30, whereby polyethylene bearing construct 35 may be secured to metal base construct 30.

In use, the socket of the acetabulum of hip 15 is removed, metal base construct 30 is secured to hip 15 via screws 55 and press fit with the acetabulum. Then polyethylene liner construct 35 is seated into metal base construct 30 until polyethylene bearing construct 35 engages the metal seat 40.

In accordance with the present invention, metal base construct 30 is formed with a bimetal construction. More particularly, the metal base construct 30 is composed of two different metals, a first metal 87 which engages hip 15 and a second metal

90 which engages polyethylene liner construct 35.

Each of these metals is selected so that its characteristics are well suited to its particular function. More particularly, first metal 87 (i.e., the one that engages hip 15) is selected so as to provide a superior bone-engaging face, while second metal 90 (i.e., the one that engages polyethylene liner construct 35) is selected so as to provide a superior polyethylene-engaging face. By combining the different material characteristics of two different metals in base metal construct 10, it is possible to simultaneously form a superior bone-engaging face and a superior polyethylene-engaging face. Among other things, by selecting two appropriate metals for the metal base construct, superior bone ingrowth can be achieved while still avoiding the aforementioned problems with "backside wear".

For instance, a base metal construct 10 may be formed whose bone-engaging surfaces are formed from titanium and whose polyethylene-engaging surfaces are formed from CoCrMo. This construction places a good

bone ingrowth metal against the bone and a good polyethylene-engaging metal against the polyethylene, whereby to provide a significantly superior prosthetic acetabular component 10.

5 It is also possible to use other metals that are suitable in both strength, biocompatibility, and joinability to make the bimetal tibial component construct.

10 By way of example but not limitation, first metal 87 may comprise titanium, titanium alloys, tantalum, tantalum alloys or other metals and/or metal alloys consistent with the present invention. Among other things, first metal 87 is preferably a material which is highly biocompatible and which exhibits good bone ingrowth properties.

15 By way of further example but not limitation, second metal 90 may comprise CoCrMo, cobalt based alloys, stainless steels, zirconium based alloys or other metals and/or metal alloys consistent with the present invention. Among other things, second metal 90 is preferably a material which has relatively high

hardness and which is scratch resistant. For the purposes of the present invention, the term bimetal may be defined as a composite of two metals, where each of the metals has a different primary constituent. The bimetal construct can be formed from two different commercially pure metals, from two alloys of different base metals, or a combination thereof.

The bimetal construct can be fabricated using a variety of techniques. In one preferred form of the invention, the bimetal construct is fabricated using the method disclosed in pending U.S. Patent Application Serial No. 09/079,502, which patent application is hereby incorporated herein by reference. Alternatively, the bimetal construct can be fabricated by other techniques such as plasma spray, diffusion bonding, sintering, or metallurgical methods, e.g., such as a method of the sort disclosed in U.S. Patent No. 5,323,954 (Shetty).